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Houston, Texas 77058

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Software Requirements Specification (SRS)
for the
Human Research Facility
Muscle Atrophy Research and Exercise System
(MARES) Workstation Client Software

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for the
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Software Requirements Specification (SRS)
for the
Human Research Facility
Muscle Atrophy Research and Exercise System
(MARES) Workstation Client Software

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ACRONYMS AND ABBREVIATIONS

CCB	Configuration Control Board
CR	Change Request
CSCI	Computer Software Configuration Item
HRD	Hardware Requirements Document
HRF	Human Research Facility
HRFIS	Human Research Facility Interface Specification
IDD	Interface Definition Document
ISS	International Space Station
JSC	Johnson Space Center
LMSO	Lockheed Martin Space Operations
LSDS	Life Sciences Data System
MARES	Muscle Atrophy Research and Exercise System
MB	Megabyte
NASA	National Aeronautics and Space Administration
OS	Operating System
R2WS	Rack 2 Workstation
SAP	Software Acceptance Plan
SDD	Software Design Document
SDP	Software Development Plan
SRS	Software Requirements Specification
STP	Software Test Plan
TCP/IP	Transmission Control Protocol/Internet Protocol

ABSTRACT

This document was prepared by Lockheed Martin Space Operations (LMSO) Company for the National Aeronautics and Space Administration (NASA) Johnson Space Center (JSC) under contract number NAS9-19100.

This document is the design specification and certification plan for the Muscle Atrophy Research and Exercise System (MARES) Workstation Client Software, which is part of the Human Research Facility (HRF) for the International Space Station (ISS).

PREFACE

This Software Requirements Specification (SRS) defines the minimum set of requirements for the HRF MARES Workstation Client Software for the ISS. This document is under the control of the HRF Configuration Control Board (CCB).

HRF CCB Chairman	DATE
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1.0 INTRODUCTION

1.1 PURPOSE

This Software Requirements Specification (SRS) serves as a repository for the design requirements for the Muscle Atrophy Research and Exercise System (MARES) Workstation Client Software developed for the International Space Station (ISS) Human Research Facility (HRF). MARES Workstation Client Software will accept real-time MARES data from the MARES Software and send it to HRF Common Software for downlink. The Software Development Plan (SDP) for the HRF describes and delineates the methods by which the National Aeronautics and Space Administration's (NASA) Johnson Space Center (JSC) will design, develop, test, and certify (as required) the HRF MARES Workstation Client Software.

1.2 SCOPE

The requirements established herein are applicable only to the MARES Workstation Client Software. This SRS identifies unique and general construction design requirements in Section 3.0, Software Design Requirements.

2.0 APPLICABLE DOCUMENTS

The following documents are considered applicable to this SRS because they are each specifically called out in individual requirements in this SRS. No document will appear in this section without being referenced in this SRS. Revision letters shall accompany the document call-outs so that work authorization documents can be written from this SRS. If the HRF Master Document List, LS-71029, is revised to reflect an updated document revision, the impact to this and all other HRF documentation will be assessed via a Change Request (CR) processed through the HRF Configuration Control Board (CCB).

NOTE: For all HRF documentation, the HRF Master Document is the source for the revision letters. Refer to the HRF Master Document list for latest revisions.

<u>Document Number</u>	<u>Rev.</u>	<u>Document Title</u>
LS-71020	B	Software Development Plan for the Human Research Facility
LS-71042-14-4	A	Interface Definition Document (IDD) for the Human Research Facility (HRF) Rack 2 Workstation (R2WS)
LS-71053-1	Issue 3, Ver. 3	Hardware Requirements Document for the Muscle Atrophy Research and Exercise System (MARES) of the Human Research Facility (HRF)
LS-71062-8	C	Interface Design Document for the Human Research Facility Common Software
LS-71083	C	Software Design Document for the Human Research Facility
LS-71090-1	Basic	Hardware Requirements Document for the Human Research Facility Muscle Atrophy Research and Exercise System (MARES) Rack
MARES-0000- SP-103-NTE	Basic	HRF Interface Specification – MARES and MARES Rack System
TBD		Version Description Document for the Human Research Facility Muscle Atrophy Research and Exercise System (MARES) Workstation Client Software

3.0 SOFTWARE DESIGN REQUIREMENTS

This section contains the software requirements for the HRF MARES Workstation Client Software Computer Software Configuration Item (CSCI). These requirements were derived from functional requirements in the HRF MARES Hardware Requirements Document (HRD), the HRF MARES Rack HRD, and the HRF Interface Specification (LS-71053-1, LS-71090-1, and MARES-0000-SP-103-NTE). Each requirement in this section shall be traceable back to a functional requirement in the HRF MARES HRD, the HRF MARES Rack HRD, or the HRF Interface Specification (LS-71053-1, LS-71090-1, and MARES-0000-SP-103-NTE). The verification process for the CSCI is listed in the Software Certification Matrix (Appendix A). The type, category, and operational modes required shall be identified for the CSCI. The Requirements Traceability Matrix, and the Requirements Allocation Matrix are located in Appendix B.

3.1 DEFINITIONS

Please refer to the Software Development Plan for the Human Research Facility (LS-71020) for definitions of the software type, software category, and configuration item terms.

MARES Workstation Client Software - Software designed to accept real-time MARES data from MARES Server Software and send it to HRF Common Software for downlink.

3.2 MODES

Normal Mode - The CSCI performs in accordance with the requirements defined.

3.3 MARES WORKSTATION CLIENT CSCI

The MARES Workstation Client CSCI provides the interface between MARES Software and the HRF Common Software for the purpose of real-time MARES experiment data downlink. The MARES Workstation Client CSCI will be a custom-build, flight software application and will be tested against the requirements outlined in the following sections.

3.3.1 CSCI Functional and Performance Requirements

- a) The MARES Workstation Client CSCI shall receive experiment data packets, using Transmission Control Protocol/Internet Protocol (TCP/IP) socket protocol.
- b) The MARES Workstation Client CSCI shall receive experiment data packets with an average throughput of 100 Kbytes/s in 5 seconds.
- c) The MARES Workstation Client CSCI shall connect to the MARES Software as a single TCP/IP client.

- d) The MARES Workstation Client CSCI shall be able to continuously receive experiment data packets from the MARES Software after its TCP/IP connection has been established.
- e) The MARES Workstation Client CSCI shall send error codes in the downlinked experiment data packets to signal a Workstation Client to MARES Software connection error. These error codes shall be defined in the Version Description Document for the MARES Workstation Client Software.
- f) The MARES Workstation Client CSCI shall log non-fatal errors that occur during execution of the CSCI.
- g) The MARES Workstation Client CSCI shall be capable of being initiated without a user logging into the Operating System (OS).
- h) The MARES Workstation Client CSCI shall operate without any user intervention.
- i) The MARES Workstation Client CSCI shall terminate cleanly when the OS is shut down.
- j) The MARES Workstation Client CSCI shall terminate on receipt of a command from the ground through HRF Common Software. This command shall be defined in the Version Description Document for the MARES Workstation Client Software.
- k) The MARES Workstation Client CSCI shall connect to HRF Common Software with a different experiment ID for each MARES experiment.

3.3.2 CSCI External Interface Requirements

- a) The MARES Workstation Client CSCI shall interface with HRF Common Software. This external interface shall be used to initiate the execution of the MARES Workstation Client CSCI without user intervention. The interface is defined in the Interface Design Document for the Human Research Facility Common Software (LS-71062-8).
- b) The MARES Workstation Client CSCI shall interface with HRF Common Software. This external interface shall be used to send real-time MARES experiment data packets to the HRF Common Software. The interface is defined in the Interface Design Document for the Human Research Facility Common Software (LS-71062-8).
- c) The MARES Workstation Client CSCI shall interface with the MARES software. This external interface shall be used to receive real-time MARES experiment data packets from the MARES Software. The interface is defined in the HRF Interface Specification – MARES and MARES Rack System (MARES-0000-SP-103-NTE).
- d) The MARES Workstation Client CSCI shall interface with HRF Common Software. This external interface shall be used to terminate the MARES Workstation Client CSCI without user intervention. The interface is defined in the Interface Design Document for the Human Research Facility Common Software (LS-71062-8).

3.3.2.1 Word/Byte Notations, Types and Data Transmissions

3.3.2.1.1 Word/Byte Notations

The MARES Workstation Client CSCI shall use the word/byte notations as specified in Paragraph 3.1.1, Notations in SSP 52050. (LS-71000A, Section 6.2.3.6)

3.3.2.1.2 Data Types

The MARES Workstation Client CSCI shall use the data types as specified in Paragraph 3.2.1 and subsections, Data Formats in SSP 52050. (LS-71000A, Section 6.2.3.6)

3.3.2.1.3 Real-time Data

Real-time data for the MARES Workstation Client CSCI shall be formatted as defined in the HRF Interface Specification - MARES and MARES Rack System (MARES-0000-SP-103-NTE).

3.3.2.1.4 Command and Data Handling Services

The MARES Workstation Client CSCI shall request services in accordance with LS-71062-8, Interface Definition Document for the Human Research Facility Common Software. (LS-71000A, Section 6.2.3.8)

3.3.3 CSCI Internal Interface Requirements

The internal MARES Workstation Client CSCI interfaces will be defined in the Software Design Document for the Human Research Facility (LS-71083).

3.3.4 CSCI Internal Data Requirements

The internal MARES Workstation Client CSCI data will be defined in the Software Design Document for the Human Research Facility (LS-71083).

3.3.5 CSCI Adaptation Requirements

The MARES Workstation Client CSCI shall read file pathnames required for proper execution of the software from a configuration file rather than “hard coded” into the software. (LS-71000, Section 6.3.3.2A)

3.3.6 Software Safety Requirements

The MARES Workstation Client CSCI shall not be used to hold, store, or process any safety critical parameters or commands.

3.3.7 Data Privacy Requirements

There are no CSCI data privacy requirements for the MARES Workstation Client CSCI.

3.3.8 CSCI Environment Requirements

- a) The MARES Workstation Client CSCI shall execute in the environment described in the HRF Rack 2 Workstation Interface Definition Document (IDD) (LS-71042-14-4).
- b) The MARES Workstation Client CSCI shall utilize no more than 10 Megabytes (MB) of disk space.
- c) The MARES Workstation Client CSCI shall utilize no more than 5 MB of memory.

3.3.9 Software Quality Factors

- a) The MARES Workstation Client CSCI executable shall generate consistent results given the same initialization data.
- b) The MARES Workstation Client CSCI source code shall compile and build an executable image without producing any compiler or build errors.

3.3.10 Design and Implementation Constraints

The MARES Workstation Client CSCI will be developed in accordance with the HRF Coding Style Guide in Appendix C of the Software Development Plan for the Human Research Facility (LS-71020).

3.3.11 Precedence and Criticality of Requirements

All requirements are equally weighted and are not listed in any order of precedence or criticality.

APPENDIX A

SOFTWARE CERTIFICATION MATRIX

All software will be qualified through the use of a Software Test Plan (STP) or a Software Acceptance Plan (SAP). The method used for testing (e.g., test, analysis, inspection, similarity, and demonstration) is identified in the test plan. In general, most software will use demonstration as the primary method.

Paragraph Number	Requirement	Qualification Procedure (STP/SAP Analysis)	(0) (X)	Comment/Test Plan Number
3.3	MARES Workstation Client Software: The MARES Workstation Client CSCI provides the interface between MARES Software and the HRF Common Software for the purpose of real-time MARES experiment data downlink. The MARES Workstation Client CSCI will be a custom-build, flight software application and will be tested against the requirements outlined in the following sections.			
3.3.1	CSCI Functional and Performance Requirements			
3.3.1 a)	The MARES Workstation Client CSCI shall receive experiment data packets, using TCP/IP socket protocol.	STP, Analysis		
3.3.1 b)	The MARES Workstation Client CSCI shall receive experiment data packets with an average throughput of 100 Kbytes/s in 5 seconds.	STP		
3.3.1 c)	The MARES Workstation Client CSCI shall connect to the MARES Software as a TCP/IP client.	STP, Analysis		
3.3.1 d)	The MARES Workstation Client CSCI shall continuously receive experiment data packets from the MARES Software after its TCP/IP connection has been established.	STP		
3.3.1 e)	The MARES Workstation Client CSCI shall send error codes in the downlinked experiment data packets to signal a Workstation Client to MARES Software connection error. These error codes shall be defined in the Version Description Document for the MARES Workstation Client.	STP, Analysis		
3.3.1 f)	The MARES Workstation Client CSCI shall log non-fatal errors that occur during execution of the CSCI.	STP		
3.3.1 g)	The MARES Workstation Client CSCI shall be capable of being initiated without a user logging into the OS.	STP		
3.3.1 h)	The MARES Workstation Client CSCI shall operate without any user intervention.	STP		
3.3.1 i)	The MARES Workstation Client CSCI shall terminate cleanly when the OS is shut down.	STP		
3.3.1 j)	The MARES Workstation Client CSCI shall terminate on receipt of a command from the ground through HRF Common Software. This command shall be defined in the Version Description Document for the MARES Workstation Client.	STP, Analysis		

Paragraph Number	Requirement	Qualification Procedure (STP/SAP Analysis)	(0) (X)	Comment/Test Plan Number
3.3.1 k)	The MARES Workstation Client CSCI shall connect to HRF Common Software with a different experiment ID for each MARES experiment.	STP		
3.3.2	CSCI External Interface Requirements			
3.3.2 a)	The MARES Workstation Client CSCI will interface with HRF Common Software. This external interface shall be used to initiate the execution of the MARES Workstation Client CSCI without user intervention. The interface is defined in the Software Requirements Specification (SRS) for the HRF Common Software (LS-71062).	STP		
3.3.2 b)	The MARES Workstation Client CSCI will interface with HRF Common Software. This external interface shall be used to send real-time MARES experiment data packets to the HRF Common Software. The interface is defined in the Interface Design Document for the Human Research Facility (LS-71062-8).	STP		
3.3.2 c)	The MARES Workstation Client CSCI will interface with the MARES software. This external interface shall be used to receive real-time MARES experiment data packets from the MARES Software. The interface is defined in the HRF Interface Specification – MARES and MARES Rack System (MARES-0000-SP-103-NTE).	STP		
3.3.2 d)	The MARES Workstation Client CSCI will interface with HRF Common Software. This external interface shall be used to terminate the MARES Workstation Client CSCI without user intervention. The interface is defined in the Interface Design Document for the Human Research Facility (LS-71062-8).	STP		
3.3.2.1	Word/Byte Notations, Types and Data Transmissions			
3.3.2.1.1	Word/Byte Notations The MARES Workstation Client CSCI shall use the word/byte notations as specified in Paragraph 3.1.1, Notations in SSP 52050. (LS-71000, Section 6.2.3.6)	Analysis		
3.3.2.1.2	Data Types The MARES Workstation Client CSCI shall use the data types as specified in Paragraph 3.2.1 and subsections, Data Formats in SSP 52050. (LS-71000, Section 6.2.3.6)	Analysis		
3.3.2.1.3	Real-time Data Real-time data for the MARES Workstation Client CSCI shall be formatted as defined in the HRF Interface Specification - MARES and MARES Rack System (MARES-0000-SP-103-NTE).	Analysis		
3.3.2.1.4	Command and Data Handling Services The MARES Workstation Client CSCI shall request services in accordance with LS-71062-8, Interface Definition Document for the Human Research Facility Common Software. (LS-71000, Section 6.3.3.3)	Analysis		

Paragraph Number	Requirement	Qualification Procedure (STP/SAP Analysis)	(0) (X)	Comment/Test Plan Number
3.3.3	CSCI Internal Interface Requirements The internal MARES Workstation Client CSCI interfaces will be defined in the Software Design Document for the Human Research Facility (LS-71083).			
3.3.4	CSCI Internal Data Requirements The internal MARES Workstation Client CSCI data will be defined in the Software Design Document for the Human Research Facility (LS-71083).			
3.3.5	CSCI Adaptation Requirements The MARES Workstation Client CSCI shall read file pathnames required for proper execution of the software from a configuration file rather than “hard coded” into the software. (LS-71000, Section 6.3.3.2A)	STP		
3.3.6	Software Safety Requirements The MARES Workstation Client CSCI shall not be used to hold, store, or process any safety critical parameters or commands.	Analysis		
3.3.7	Data Privacy Requirements There are no data privacy requirements for the MARES Workstation Client CSCI.			
3.3.8	CSCI Environment Requirements			
3.3.8 a)	The MARES Workstation Client CSCI shall execute in the environment described in the Interface Definition Document (IDD) for the Human Research Facility Rack 2 Workstation (R2WS) (LS-71042-14-4).	STP		
3.3.8 b)	The MARES Workstation Client CSCI shall utilize no more than 10 MB of disk space.	STP		
3.3.8 c)	The MARES Workstation Client CSCI shall utilize no more than 5 MB of memory.	STP		
3.3.1.9	Software Quality Factors			
3.3.1.9 a)	The MARES Workstation Client CSCI executable shall generate consistent results given the same initialization data.	STP		
3.3.1.9 b)	The MARES Workstation Client CSCI source code shall compile and build an executable image without producing any compiler or build errors.	STP		
3.3.10	Design and Implementation Constraints The MARES Workstation Client CSCI will be developed in accordance with the HRF Coding Style Guide in Appendix C of the Software Development Plan for the Human Research Facility (LS-71020).			
3.3.11	Precedence and Criticality of Requirements All requirements are equally weighted and are not listed in any order of precedence or criticality.			

APPENDIX B

REQUIREMENTS MATRICES

B-1 REQUIREMENTS TRACEABILITY MATRIX

Requirement Identifier	Requirements Text	CSCI Requirement
HRD-MARES-3.1.5.3.1	It shall be possible to transmit in real-time to HRF for downlink MARES related data (measured, acquired and processed) during the performance of the MARES experiment. MARES shall transmit this data to be downlinked to HRF, using TCP/IP protocol, with a maximum throughput of 100 Kbytes/s.	3.3.1 a) 3.3.1 b)
HRD-MARES Rack-3.2.7.10.1	All HRF MARES Rack to MARES interfaces shall comply with the applicable requirements of MARES-0000-SP-103-NTE, HRF Interface Specification.	3.3.1 a) 3.3.1 b) 3.3.1 c) 3.3.1 d)
HRFIS-3.2.3.2.5.1.1.10/B	During the execution of experiments, MARES will transmit the experiment related data to HRF using TCP/IP stream socket protocol in a client/server configuration with an average throughput of 100 Kbytes/s in 5 seconds.	3.3.1 a) 3.3.1 b)
HRFIS-3.2.3.2.5.1.1.20/B	MARES will act as server waiting (listen) for the HRF (client) connection at the IP address MARES_HRF_IP port number 2000.	3.3.1 c)
HRFIS-3.2.3.2.5.1.1.30/M	MARES will support the connection of only one client.	3.3.1 c)
HRFIS-3.2.3.2.5.1.1.40/B	During HRF client connection, MARES will, at worst case, continuously send the experiment data packets.	3.3.1 d)

B-2 REQUIREMENTS ALLOCATION MATRIX

CSCI Requirement	Requirement Identifier		
3.3.1 a)	HRD-MARES-3.1.5.3.1	HRD-MARES Rack-3.2.7.10.1	HRFIS-3.2.3.2.5.1.1.10/B
3.3.1 b)	HRD-MARES-3.1.5.3.1	HRD-MARES Rack-3.2.7.10.1	HRFIS-3.2.3.2.5.1.1.10/B
3.3.1 c)		HRD-MARES Rack-3.2.7.10.1	HRFIS-3.2.3.2.5.1.1.20/B HRFIS-3.2.3.2.5.1.1.30/M
3.3.1 d)		HRD-MARES Rack-3.2.7.10.1	HRFIS-3.2.3.2.5.1.1.40/B
3.3.1 e)			
3.3.1 f)			
3.3.1 g)			
3.3.1 h)			
3.3.1 i)			
3.3.1 j)			

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